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International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 4 : F23N 5/08	A1	(11) International Publication Number: WO 86/ 04664 (43) International Publication Date: 14 August 1986 (14.08.86)

(21) International Application Number: PCT/SE86/00056
(22) International Filing Date: 11 February 1986 (11.02.86)
(31) Priority Application Number: 8500626-0
(32) Priority Date: 12 February 1985 (12.02.85)
(33) Priority Country: SE

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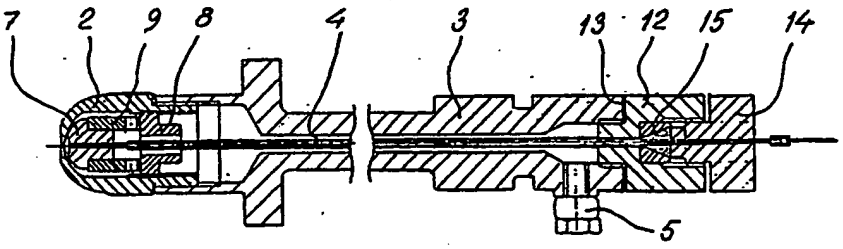
(81) Designated States: AT (European patent), BE (European patent), CH (European patent), DE (European patent), DK, FI, FR (European patent), GB (European patent), IT (European patent), LU (European patent), NL (European patent), NO, SE (European patent).

Published
With international search report.
In English translation (filed in Swedish).

(54) Title: A METHOD FOR THE CONTROL OF A BURNER EQUIPPED WITH AN INJECTOR NOZZLE AND AN ARRANGEMENT FOR EXECUTING THE METHOD



(57) Abstract

A method for the control of a burner (1) equipped with an injector nozzle (2), through optical monitoring of the flame from the burner (1) and control of the supply of fuel and/or oxygen to the burner depending on the presence or absence of ligth from the flame and/or depending on the instantaneous value of the air factor in the combustion gases which is determined from the flame by spectral analysis. The method is characterized in that the light, which penetrates from the flame through the orifice (6) of the injector nozzle (2) via which fuel is injected into the combustion chamber, is detected. The invention also relates to an arrangement for carrying out the method, comprising a burner (1) with an injector nozzle (2) via which fuel is injected into a combustion chamber. Inside the orifice (6) via which fuel is injected into the combustion chamber are arranged in the injector nozzle means (10) for receiving light which penetrates from the flame through the orifice. The aforementioned means consist preferably of a fibre-optic light conductor (10) which extends into the nozzle (2) and discharges inside the aforementioned orifice (6), immediately behind the latter.

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A METHOD FOR THE CONTROL OF A BURNER EQUIPPED WITH AN INJECTOR NOZZLE AND AN ARRANGEMENT FOR EXECUTING THE METHOD.

The present invention relates to a method for the control of a burner equipped with an injector nozzle through optical monitoring of the flame from the burner and regulation of the supply of fuel and/or oxygen to the burner depending on the presence or absence of light from the flame and/or depending on the value of the air factor in the combustion gases which is determined by spectral analysis of light from the flame, and an arrangement designed for carrying out the method.

In combustion plants of various kinds optical monitoring of the flame from the burner is a frequently used method for checking the function of the burner and for regulating the supply of fuel and/or air, that is to say oxygen to the burner. According to the most simple application of optical flame monitoring only the presence or absence of light from the flame is detected, in conjunction with which the supply of fuel to the burner nozzle is interrupted when the radiation of light from the flame ceases or is drastically reduced. In more advanced systems light from the flame is subjected to spectral analysis in order thereby to obtain data relating to the actual value of the air factor in the combustion gases, and to compare the actual value with a predetermined reference value. Any difference between the actual value and the reference value then causes a control signal to be generated for the purpose of regulating the supply of fuel and/or air, that is to say oxygen, to the burner, so that the desired air factor is maintained continuously during combustion.

Previously disclosed systems of this kind are based on the fact that the radiation given off by the flame contains data in respect of the composition of the gases present in the combustion gases. Various substances or compounds, such as O_2, CO_2 and H_2, etc., which are present in the combustion gases in the flame, will thus produce radiation, the intensity of which differs noticeably from the radiation intensity in general within certain wave ranges which

are characteristic of the substance or compound in question and which are also dependent on the content of the substance or compound in question. Stoichiometric combustion thus produces a spectrum which can be shown by spectral analysis of the luminous radiation from the flame to be characteristic of this state. Combustion in a state of excess air or in a state of insufficient air will produce corresponding spectra which are characteristic of these states. With the help of the data obtained by spectral analysis of the luminous radiation from the flame, it is possible to calculate the instantaneous value of the air factor and to compare this with a predetermined reference value in a comparator. The difference between the actual value and the reference value can then be caused to generate a control signal for the control of the supply of fuel and/or air to the burner so that the air factor can be maintained continuously at the predetermined value. A previously disclosed system of this kind is described in US Patent Specification 4 043 742.

To obtain a reliable result by the method described above, certain conditions must, however, be present. Thus, one must be certain that the light which is to be processed by spectral analysis actually originates from the flame of the burner, and not from other sources of radiation, such as an adjacent burner, or from the walls of the combustion chamber. It is also particularly important that the detected luminous radiation should not be exposed prior to spectral analysis to any influence of such a kind as will cause its character to alter, for example by filtering or in some other way.

One feature which is shared by the previously disclosed systems for the optical monitoring of the flame is that the flame is observed through an orifice or a window in the wall of the combustion chamber. Arranged in the wall is a channel which is directed towards the flame and through which light from the flame can find its way out to be received or detected by means provided for this purpose. The channel or orifice is also provided with a window made of a transparent, heat-resistant material in order to protect the means used for detection against the influence of the high temperatures prevailing in the combustion chamber.

Monitoring of the flame through an orifice or a channel in the

wall of the combustion chamber involves certain disadvantages, however, which have a negative effect on the reliability of the intended detection of light from the flame of the burner. As a consequence of the positioning of the orifice or the channel in the wall of the combustion chamber opposite or beside the burner, it is not possible to prevent luminous radiation from the walls of the combustion chamber from penetrating into the orifice or channel to a certain extent and being detected. If several burners are arranged in the combustion chamber, it can hardly be avoided that luminous radiation from an adjacent burner also to a certain extent penetrates into the detection opening or the channel for a particular flame. The protective window which closes off the orifice or channel will take on a coating of combustion products on the side facing the combustion chamber after only a short period of use, and this coating will act as a filter for the luminous radiation which is detected in the orifice or channel. These factors can thus cause the light which is detected to produce a false picture of the state existing in the flame. Control of the burner based on spectral analysis of light which is subjected in the abovementioned manner to irrelevant influences is thus likely to be defective to a corresponding degree.

The object of the present invention is to make available a method for the control of a burner of the kind indicated in the introduction, in which the disadvantages described above associated with the previously disclosed systems are avoided, and in which the influence of luminous radiation from adjacent burners or from the walls of the combustion chamber is minimized and the light detected from the flame represents in a reliable fashion the conditions of combustion existing in the flame at the time of detection. An object of the invention is also to make available a method which is suitable not only for the simple optical monitoring of the flame and for the regulation of the fuel supply depending on the presence or absence of light from the flame, but also for the more advanced, continuous control of the supply of fuel and/or oxygen to the burner depending on the instantaneous value of the air factor in the combustion gases which is determined by spectral analysis of light from the flame.

A further object of the present invention is to make available

an arrangement for the execution of the method which is of simple construction and in which the orifice via which the light from the flame is detected automatically is kept free of deposits which could otherwise affect the quality of the detected light, at the same time continuously cooling the means which are used to receive the light.

The objects described above are achieved by a method and an arrangement whose special characteristics are indicated in the following Patent Claims.

The invention is described below in relation to illustrative embodiments shown in the accompanying drawings, in which:

- Fig. 1 shows a longitudinal section through an injector nozzle included in the arrangement in accordance with the invention and designed in accordance with the invention;
- Fig. 2 shows on an enlarged scale a longitudinal section through the front part of the injector nozzle;
- Fig. 3 shows on an enlarged scale a partial section through the rear end of the nozzle holder which supports the nozzle; and
- Fig. 4 illustrates schematically a basic circuit diagram of a control system for the control of a burner in accordance with the invention.

In the method in accordance with the invention a burner equipped with an injector nozzle is controlled by the flame produced by the burner being monitored optically by detection of the light from the flame. The detected light can be caused to actuate a photoelectric cell, which, depending on the presence or the absence of light, can be caused to generate a control signal for regulating the supply of fuel to the burner. Since the detected light contains data in respect of the conditions of combustion existing at the time of detection, the detected light is preferably subjected to spectral analysis in order thereby to obtain an instantaneous value for the air factor in the combustion gases, which is then compared with a predetermined reference value, in conjunction with which any difference between the actual value and the reference value can be caused to generate a control signal for the control of the supply of fuel and/or air, that is to say oxygen, to the burner, so that the desired reference value for the air factor is

achieved. The method in accordance with the invention is characterized in that the light, which finds its way from the flame through the orifice in the injector nozzle via which fuel is injected, is detected. A number of advantages are achieved through this simple measure. The detection of the light from the flame thus takes place in the immediate vicinity of the flame, and this situation is in itself intended to reduce the risk of any undesired influence on the light from the flame which is to be detected. The fact that detection takes place from inside the nozzle eliminates or reduces to a considerable degree the risk of the luminous radiation being influenced by adjacent burners or by the hot walls of the combustion chamber. Thanks to the fact that detection takes place inside the injector nozzle, the need for a protective window between the flame and the point of detection no longer exists, since the fuel forms a protective film which is constantly being renewed, which eliminates the risk of deposits which could otherwise produce a negative effect on the quality of the detected light.

The method in accordance with the invention is illustrated further in the following description of an arrangement for the execution of the method illustrated in the Figures in the drawings.

Illustrated in Figs. 1-3 is an injector nozzle 2 for a burner 1, which nozzle 2 is included in an arrangement in accordance with the invention. The injector nozzle 2 is supported at one end by a nozzle holder 3 which consists of a tubular metal sleeve with an axial channel 4 through which fuel is supplied to the injector nozzle 2 installed at the front end of the nozzle holder. The channel 4 is supplied with fuel via a connection 5 for the supply of fuel arranged in the rear part of the nozzle holder. The injector nozzle 2 incorporates in a previously disclosed fashion a turborator 7 arranged inside the nozzle and directly in line with its nozzle orifice 6, said turborator being provided on its front surface with spiral guide strips. The turborator 7 is kept in contact with the spray nozzle under tension by means of a locking nut 8 and a sleeve 9 provided with radial holes. Between the turborator 7 and the spray nozzle 2 is formed a space through which the fuel is forced past the front surface of the turborator and out as a thin film through the nozzle orifice 6. In accordance with

the invention the turburator is provided, directly in line with the nozzle orifice 6 in the injector nozzle 2,with an axial hole, into which is introduced a fibre-optic light conductor 10 which is appropriately enclosed within a tubular sleeve 11. The fibre-optic light conductor extends as far as the front surface of the turborator 7 and thus discharges directly inside the nozzle orifice 6 of the injector nozzle 2. The fibre-optic light conductor 10 with its protective sleeve 11 extends axially in a direction from the turborator 7 through the channel 4 of the nozzle holder 3 and then axially through an end terminal 12 screwed into the rear end of the nozzle holder 3, said end terminal forming a seal by means of a gasket 13 against the rear end of the nozzle holder 3, and then onwards out of the nozzle holder 3 through an end journal 14 which is capable of being screwed into the end terminal 12 whilst compressing a gasket 15 which sealingly encloses the protective sleeve 11 for the fibre-optic filament 10. Also attached to the end terminal 12 is a protective tube 16 which extends coaxially with the fibre-optic filament 10 and its protective sleeve 11 as far as the front part of the nozzle holder 3. The purpose of the protective tube 16 is to facilitate the installation of the fibre-optic filament.

As fuel is supplied via the connection 5, the fuel flows onwards through the channel 4 of the nozzle holder 3, through the radial holes in the sleeve 9 and past the turborator 7, and is then sprayed out through the nozzle orifice 6 of the injector nozzle 2. The film of fuel which is sprayed out through the nozzle orifice 6 in this way constitutes a curtain of fuel across the end of the fibre-optic filament 10 and cools the latter. The fuel, which is sprayed out through the nozzle orifice 6 of the injector nozzle 2 at high pressure, prevents blocking of the nozzle orifice 6, which is thus kept open all the time and permits light from the flame to enter via the nozzle orifice 6 as far as the end of the fibre-optic filament 10. The light which has been received in this way is conveyed via the fibre-optic conductor 10 and out via the nozzle holder 3.

Shown in Fig. 4 is a basic circuit diagram for the application of the invention to the control of a burner utilizing the arrangement in accordance with the invention. Installed in the

burner 1 is a spray nozzle 2 of the kind described above fitted to the nozzle holder 3 and comprising the fibre-optic light conductor 10 which discharges into the nozzle and extends out from the nozzle holder at its rear end. The nozzle holder 3 is connected via the connection 5 to a fuel supply line. Outside the nozzle holder 3 the fibre-optic filament 10 is connected to a fibre junction 17, in which the luminous beam from the fibre-optic filament 10 is divided up into three luminous beams of equivalent value, each of which is conveyed further in its own fibre-optic filament 18, 19 and 20, each of which discharges into its own filter 21, 22 and 23. The filters 21-23 are selected with appropriate characteristics to permit only light within a limited wave range to pass through. The wave ranges for the filters 21-23 are selected so that they represent three different wave ranges, each of which is characteristic of the luminous radiation which corresponds to a particular substance present in the combustion gases. The filter 21 can thus be selected so as to correspond to CO_2, the filter 22 to O_2, and the filter 23 to H_2. The light which has passed through each filter is then caused to actuate a photodetector 25, which via an amplifier 26 transmits a signal to a signal processing unit 27 in which is stored a control algorithm which, depending on the input signals, calculates the actual value of the air factor in the combustion gases and accordingly transmits an actual value signal 28 to a regulator in the form of a comparator 29. The actual value signal 28 is compared in the comparator 29 with a reference value signal 30 which has already been entered into it. Any difference between the actual value signal 28 and the reference value signal 30 causes the comparator 29 to generate an output control signal 31 to a speed controller 32 for the fan motor 33 of the fan 34. Depending on the character of the control signal 31 the fan speed is thus caused to increase or to reduce so as to increase and reduce respectively the supply of air to the burner 1, so that the continuously detected actual value of the air factor in the combustion gases is caused to agree with the reference value entered into the comparator. In the system illustrated in Fig. 4 the control signal 31 is caused to control the supply of air to the burner. It is, of course, possible to choose to cause the control signal 31 to control the supply of fuel instead.

The invention described above in relation to the illustrative embodiments shown in the drawings is not restricted to these, but can be modified within the scope of the following Patent Claims. Thus, instead of a single light conductor, it is possible to provide a number of fibre-optic light conductors 10, for example three light conductors, which extend into the nozzle enclosed within a sleeve 11, and which discharge inside the nozzle orifice 6. The need for a fibre junction 17 is avoided in this way; at the same time, the intensity of the light which is conducted to each of the filters 21, 22, 23 is three times as high as in the illustrative embodiment shown in Fig. 1.

PATENT CLAIMS

1. A method for the control of a burner (1) equipped with an injector nozzle through optical monitoring of the flame from the burner (1) and control of the supply of fuel and/or oxygen to the burner depending on the presence or absence of light from the flame and/or depending on the instantaneous value of the air factor in the combustion gases which is determined by spectral analysis of light from the flame, c h a r a c t e r i z e d in that the light, which penetrates from the flame through the orifice (6) of the injector nozzle (2) via which orifice fuel is injected into the combustion chamber, is detected.

2. An arrangement for carrying out the method according to Claim 1, comprising a burner (1) with an injector nozzle (2) via which fuel is injected into a combustion chamber, c h a r a c t e r i z e d in that inside the orifice (6) of the injector nozzle (2) via which orifice fuel is injected into the combustion chamber, means (10) are arranged in the injector nozzle (2) for receiving light which penetrates from the flame through the aforementioned orifice (6).

3. An arrangement according to Claim 2, c h a r a c t e r i z e d in that the aforementioned means comprise a fibre-optic light conductor (10) which extends into the nozzle and discharges inside the aforementioned orifice (6), immediately behind the latter.

4. An arrangement according to Claim 3, c h a r a c t e r i z e d in that the fibre-optic light conductor (10) is connected outside the nozzle (2) to a fibre junction (17) in which the light transmitted in the fibre-optic light conductor (10) is divided up into a number of luminous beams of equal value.

5. An arrangement according to Claim 3, c h a r a c t e r i z ed in that a number of fibre-optic light conductors (10) are so arranged as to extend into the nozzle and to discharge inside the aforementioned orifice (6), immediately behind the latter.

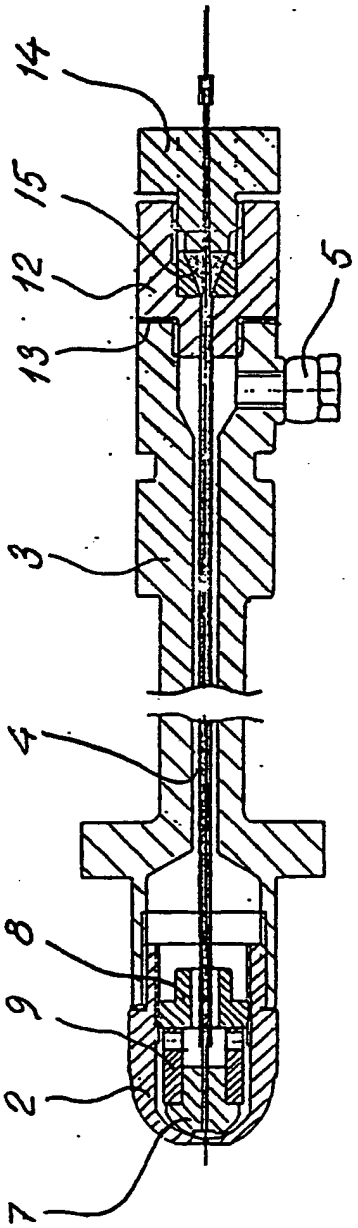

Fig.1

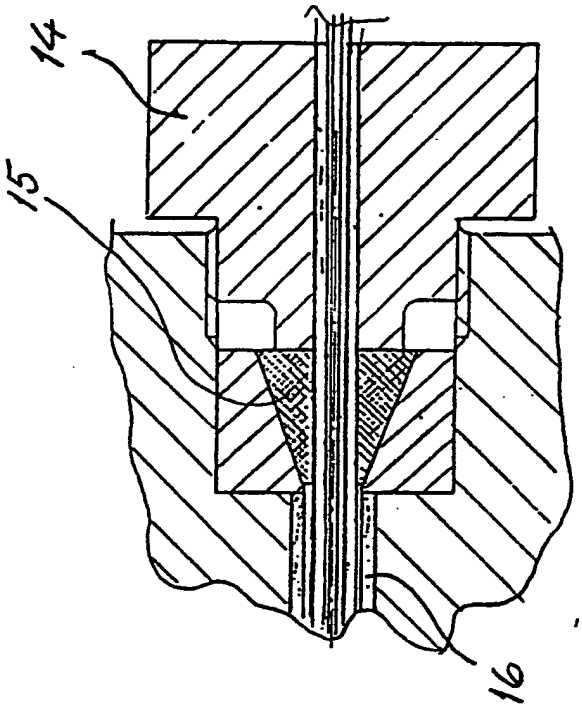

Fig 3

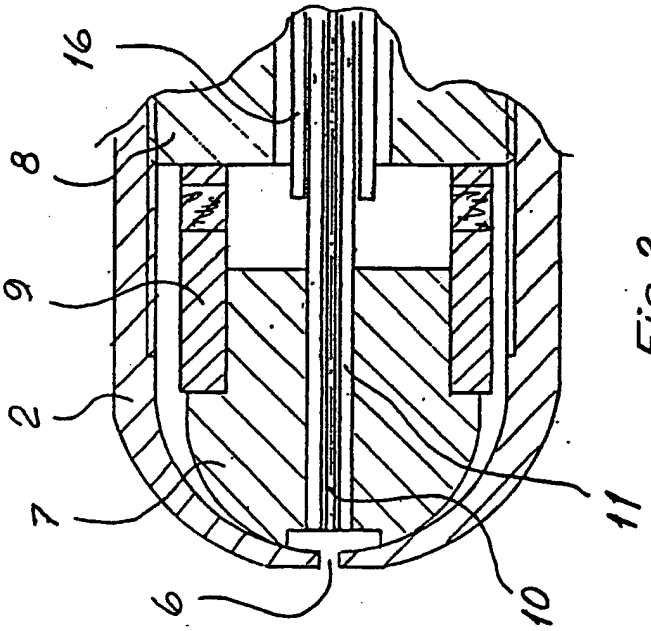

Fig 2

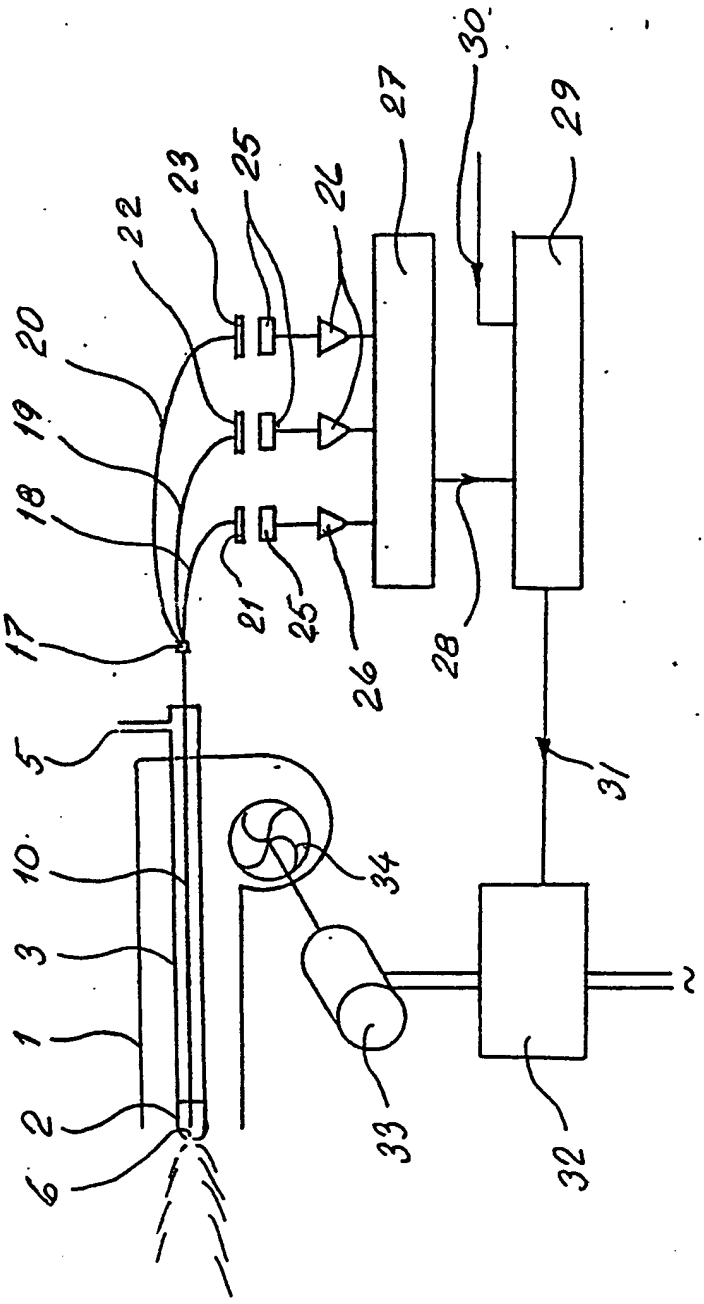

Fig 4

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE86/00056

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC 4

F 23 N 5/08

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC	F 23 N 5/00, /02, /08, /26; G 01 J 5/08
Nat Cl	24m:1/01-/03, 3
US Cl	73:346, 355; 340:247, 577-579; .../...

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
Y	US, A, 4 043 742 (EGAN ET AL) 23 August 1977 & NL, 7705469 FR, 2352252 DE, 2722318 JP, 52144829 CA, 1068510 GB, 1581384 SE, 7705330	1-5
Y	US, A, 4 547 145 (JAHNKE F C) 15 October 1985	1-5
Y	US, A, 4 461 170 (SUZUKI ET AL) 24 July 1984 & DE, 3241390 JP, 58082066 JP, 58093958	1-5
Y	DE, A, 1 816 397 (COMBUSTION ENGINEERING INC) 14 August 1969 .../...	1-2

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
1986-04-23	1986 -04- 29
International Searching Authority	**Signature of Authorized Officer**
Swedish Patent Office	Stefan Svahn

MJ

Form PCT/ISA/210 (second sheet) (January 1985).

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

II Fields Searched (cont)

356: 44;
374: 121, 131;
431: 12, 18, 24, 36, 37, 75-80

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [1]

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers ....., because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claim numbers ....., because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claim numbers ....., because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [2]

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
	& GB, 1200040 FR, 1596751 US, 3594746 BE, 725997 NL, 6815437	
Y	DE, A, 1 451 624 (VAPOR CORP) 23 October 1969	1-2
Y	US, A, 3 280 882 (HEMKER F L) 25 October 1966	1-2
Y	US, A, 3 486 835 (GROBE H H) 30 December 1969	1-2
Y	US, A, 3 299 841 (HEMKER ET AL) 24 January 1967	1-2

DERWENT-ACC-NO: 1986-225503

DERWENT-WEEK: 198634

TITLE: Optical flame-sensing control of injection type burner - has optical fibre within nozzle transmits light from flame to spectral analysing circuit controlling fuel, oxygen and air supplies

INVENTOR: DAHLANDER, P O; TYREN, C H

PATENT-ASSIGNEE: DAHLANDER P N O[DAHLI]

PRIORITY-DATA: 1985SE-0000626 (February 12, 1985) , 1987US-0084030 (August 10, 1987)

PATENT-FAMILY:

PUB-NO	PUB-DATE	LANGUAGE	PAGES	MAIN-IPC
WO 8604664 A	August 14, 1986	E	017	N/A
DK 8604882 A	October 13, 1986	N/A	000	N/A
EP 248806 A	December 16, 1987	E	000	N/A
SE 459446 B	July 3, 1989	N/A	000	N/A
SE 8500626 A	August 13, 1986	N/A	000	N/A
US 4830601 A	May 16, 1989	N/A	000	N/A

DESIGNATED-STATES: DK FI NO AT BE CH DE FR GB IT LU NL SE AT BE CH DE FR GB IT LI LU NL SE

CITED-DOCUMENTS: No-SR.Pub

APPLICATION-DATA:

PUB-NO	APPL-DESCRIPTOR	APPL-NO	APPL-DATE
EP 248806A	N/A	1986EP-0901551	February 11, 1986
US 4830601A	N/A	1987US-0084030	August 10, 1987

INT-CL (IPC): F23H005/08, F23N001/02 , F23N005/08

ABSTRACTED-PUB-NO: US 4830601A

BASIC-ABSTRACT:

A burner is equipped with an injector nozzle (2) located within a larger diameter tube through which forced air is delivered at a controllable rate, by an integral variable speed fan. Passing through the centre of the nol(2) within a protective tube (11) is an optical fibre filament (10) which is maintained cool by the film of fuel being sprayed out of the nozzle.

Light from the burner flame enters through the nozzle orifice (6) and is conveyed by the optical fibre filament (10) to the detector circuit of a control unit where filters of differing wavelengths detect the level of carbon dioxide, oxyqen, and hydrogen in the luminous radiation from the combustion gases. This spectral analysis is used to control the supply of fuel and/or

oxygen, and air to the burner to achieve the desired combustion conditions.

ABSTRACTED-PUB-NO: WO 8604664A

EQUIVALENT-ABSTRACTS:

The method for the control of a burner equipped with an injector nozzle comprises the step of continuously, during combustion, optically monitoring the flame of the burner, subjecting the light from the burner to spectral analysis for determining the instantaneous value of the air factor in the combustion gases, and controlling the supply of fuel and/or combustion air to the burner in dependence on the instantaneous value of the air factor.

Light emitted from the central portion of the flame which penetrates through the nozzle opening through which fuel is injected into the combustion chamber is picked up in a point situated in the immediate vicinity of, behind and axially with the nozzle opening. The light is further conducted out of the nozzle for being subjected to spectral analysis. (6pp)

CHOSEN-DRAWING: Dwg.2/4

TITLE-TERMS: OPTICAL FLAME SENSE CONTROL INJECTION TYPE BURNER OPTICAL FIBRE NOZZLE TRANSMIT LIGHT FLAME SPECTRAL ANALYSE CIRCUIT CONTROL FUEL OXYGEN AIR SUPPLY

DERWENT-CLASS: Q73 V07 X27

EPI-CODES: V07-X; X27-G02;

SECONDARY-ACC-NO:
Non-CPI Secondary Accession Numbers: N1986-168258